

DUNLEITH SITE
GREENSBORO, NORTH CAROLINA

LIGHT IMPRINT OVERLAY



dpz
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GREENSBORO, NORTH CAROLINA



CHARRETTE DATE
November 18, 2008 - November 22, 2008

CHARRETTE TEAM
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CHARLOTTE
ARCHITECTS AND TOWN PLANNERS

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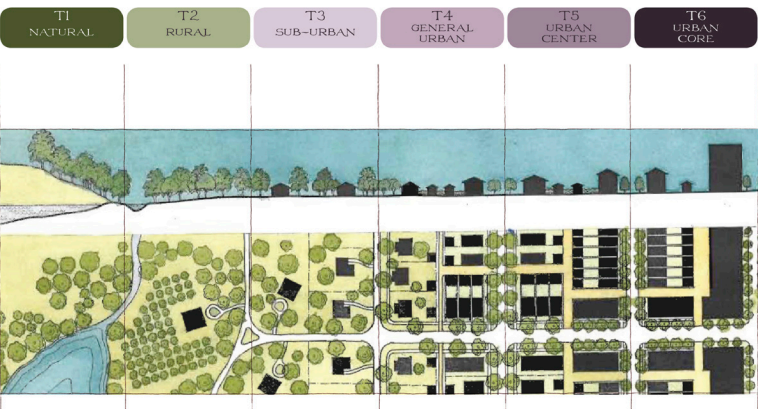
DESIGN CONSULTANTS
PIEDMONT COMMUNITY DESIGN FORUM

CLIENT
CITY OF GREENSBORO
DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT

Light Imprint ~
Matrix

The Light Imprint Matrix shown to the right is calibrated for the Dunleith Site based on the Transect zone, soil type, climate, cost, maintenance cost, and slope. These tools also match the tools that are depicted in the next page on the light imprint overlay.

TOOL BOX MATRIX



PAVING

	COMPACTED EARTH				
	WOOD PLANKS				
	STABILIZATION MAT				
	CRUSHED STONE/GRAVEL/SHELL				
	CAST/PRESSED CONCRETE PAVER BLOCK				
	GRASSED CELLULAR PLASTIC				
	GRASSED CELLULAR CONCRETE				
	PERVIOUS ASPHALT				
	ASPHALT				
	CONCRETE				
	PERVIOUS CONCRETE				
	STAMPED ASPHALT				
	STAMPED CONCRETE				
	PEA GRAVEL/WASHED STONE				
	STONE/MASONRY PAVING BLOCKS				
	WOOD PAVING BLOCKS ON CONCRETE				
	ASPHALT PAVING BLOCKS				

CHANNELING

	NATURAL CREEK				
	TERRACING				
	VEGETATIVE SWALE				
	DRAINAGE DITCH				
	STONE/RIP RAP CHANNEL				
	VEGETATIVE STONE SWALE				
	SOAKAWAY TRENCH				
	SLOPE AVENUE				
	FRENCH DRAIN				
	SHALLOW CHANNEL FOOTPATH/RAINWATER CONVEYOR				
	CONCRETE PIPE				
	GUTTER/CURB				
	PLANTING STRIP TRENCH				
	MASONRY TROUGH				
	CANAL				
	SCULPTED WATERCOURSE				
	CONCRETE TROUGH				
	ARCHIMEDES/ARCHIMEDEAN SCREW				

STORAGE

	IRRIGATION POND				
	RETENTION BASIN W/ SLOPING BANK				
	RETENTION BASIN WITH FENCE				
	RETENTION HOLLOW				
	DETENTION POND				
	DRY WELL				
	FLOWING PARK				
	RETENTION POND				
	LANDSCAPED TREE WELL				
	POOL/FOUNTAIN				
	UNDERGROUND VAULT/PIPE/CISTERN				
	GRADED TREE WELL				
	PAVED BASIN				

FILTRATION

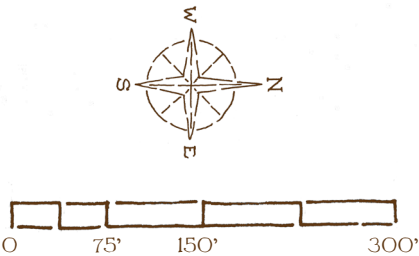
	WETLAND/SWAMP				
	FILTRATION POND				
	SHALLOW MARSH				
	NATURAL VEGETATION				
	SURFACE LANDSCAPE				
	CONSTRUCTED WETLAND				
	BIO RETENTION SWALE				
	PURIFICATION BIOTOPE				
	GREEN FINGER				
	ROOF GARDEN				
	RAIN GARDEN				
	VEGETATIVE PURIFICATION BED				
	WATERSCAPES				

DUNLEITH SITE

GREENSBORO, NORTH CAROLINA

Light Imprint ~

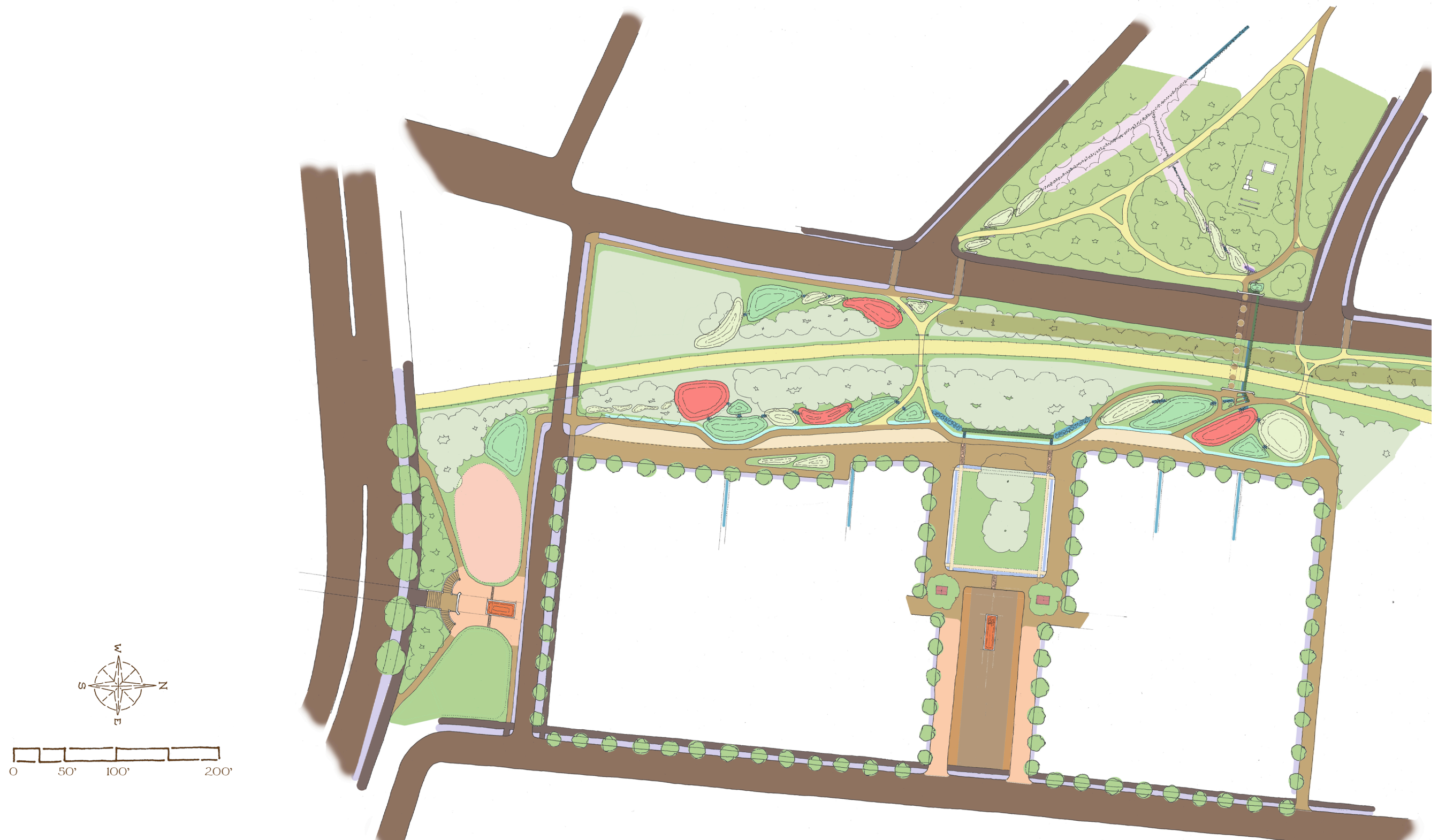
The Light Imprint tools shown on the master plan to the right detail the wide range of tools used on the Dunleith Site. This overlay uses the depth of the color to depict the different type of tools that can be used. The range of tools allows for stormwater to be handled without



- | | |
|---|---|
|  Stabilization Mat/
Crushed Stone |  Flowing Park |
|  Crushed Stone |  Retention Hollow |
|  Stone/Masonry Paving Blocks |  Retention Pond |
|  Wood Paving Blocks on Concrete |  Grated Tree Well |
|  Pervious Asphalt |  Pool/Fountain |
|  Asphalt |  Natural Vegetation |
|  Concrete |  Green Finger |
|  Stamped Concrete |  Surface Landscape |
|  Shallow Channel Footpath/
Rainwater Conveyor |  Bioretention Swale |
|  Planting Strip Trench |  Rain Garden |
|  Vegetative Swale |  Waterscape |
|  Vegetative/Stone Swale |  Vegetative Purification Bed |
|  Masonry Trough | |
|  Sculpted Watercourse | |
|  Archimedian Screw | |

DUNLEITH SITE

GREENSBORO, NORTH CAROLINA



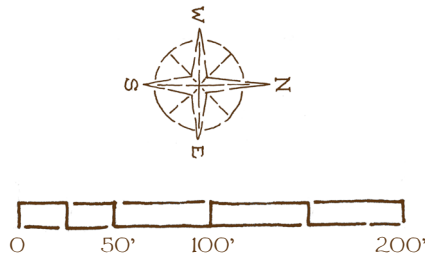
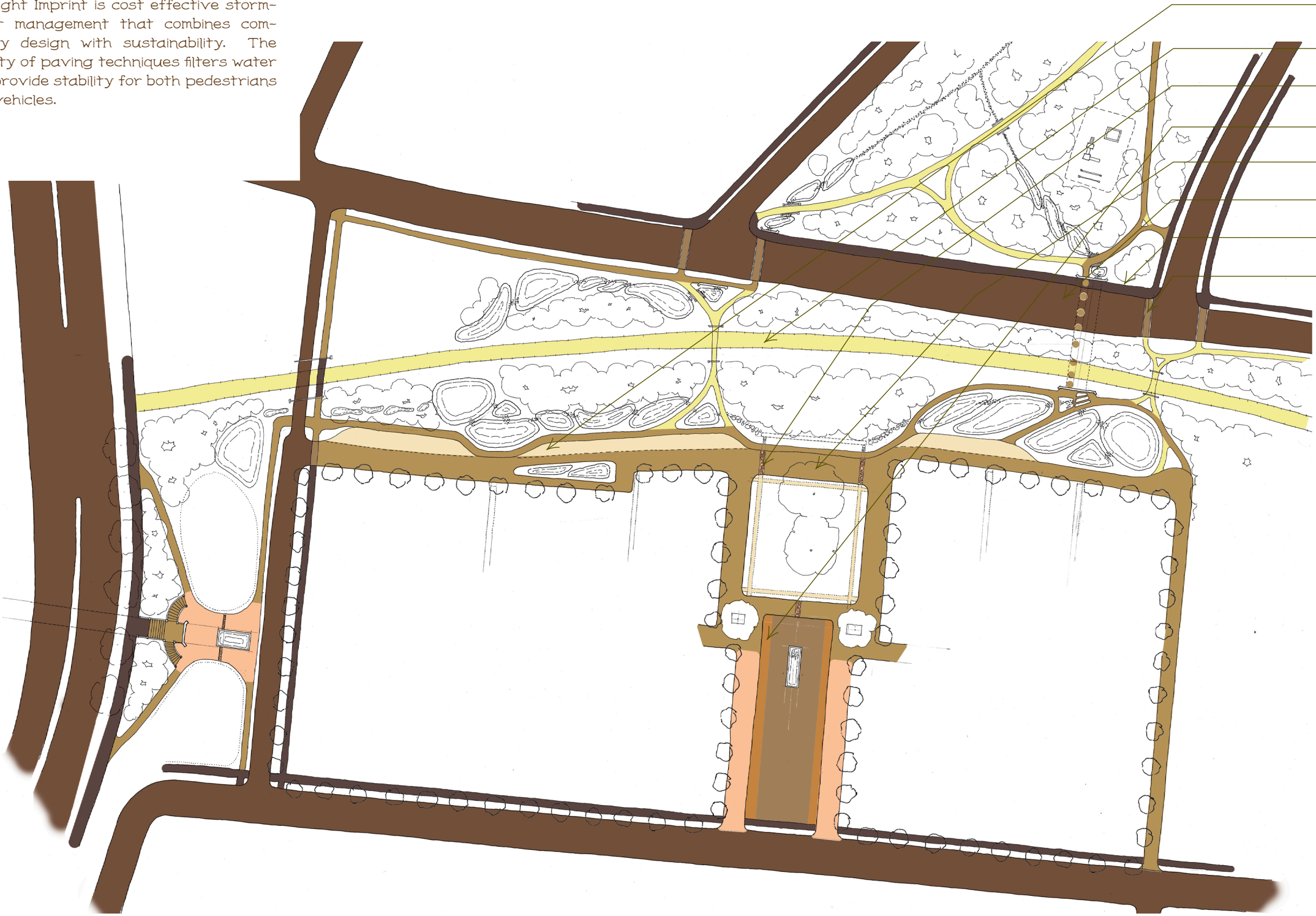
DUNLEITH SITE

GREENSBORO, NORTH CAROLINA

Light Imprint ~ Paving

Light Imprint is cost effective storm-water management that combines community design with sustainability. The variety of paving techniques filters water and provide stability for both pedestrians and vehicles.

- Stabilization Mat/
Crushed Stone
- Crushed Stone
- Stone/Masonry Paving Blocks
- Wood Paving Blocks on Concrete
- Pervious Asphalt
- Asphalt
- Concrete
- Stamped Concrete



DUNLEITH SITE

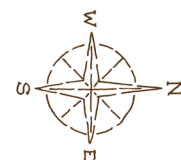
GREENSBORO, NORTH CAROLINA

Light Imprint ~ Channeling

Water must be channeled to catchment areas to store and filter. The movement of the water creates opportunity for interaction and celebration. This provides opportunities to display public art. It also creates a playground for children when it rains.



- Shallow Channel Footpath/
Rainwater Conveyor
- Planting Strip Trench
- Vegetative Swale
- Vegetative/Stone Swale
- Masonry Trough
- Archimedean Screw
- Sculpted Watercourse



DUNLEITH SITE
GREENSBORO, NORTH CAROLINA

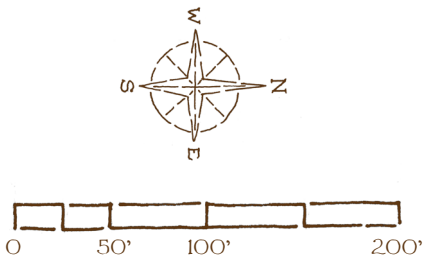
STORAGE

Light Imprint ~
Storage

The storage aspect of Light Imprint is imporant to act as final protection in the event of a heavy rain. Several retention ponds, appropriately sized, can act as overflow protection against a flood event. In addition, water is used as an amenity.



- Flowing Park
- Retention Hollow
- Retention Pond
- Grated Tree Well
- Pool/Fountain



DUNLEITH SITE

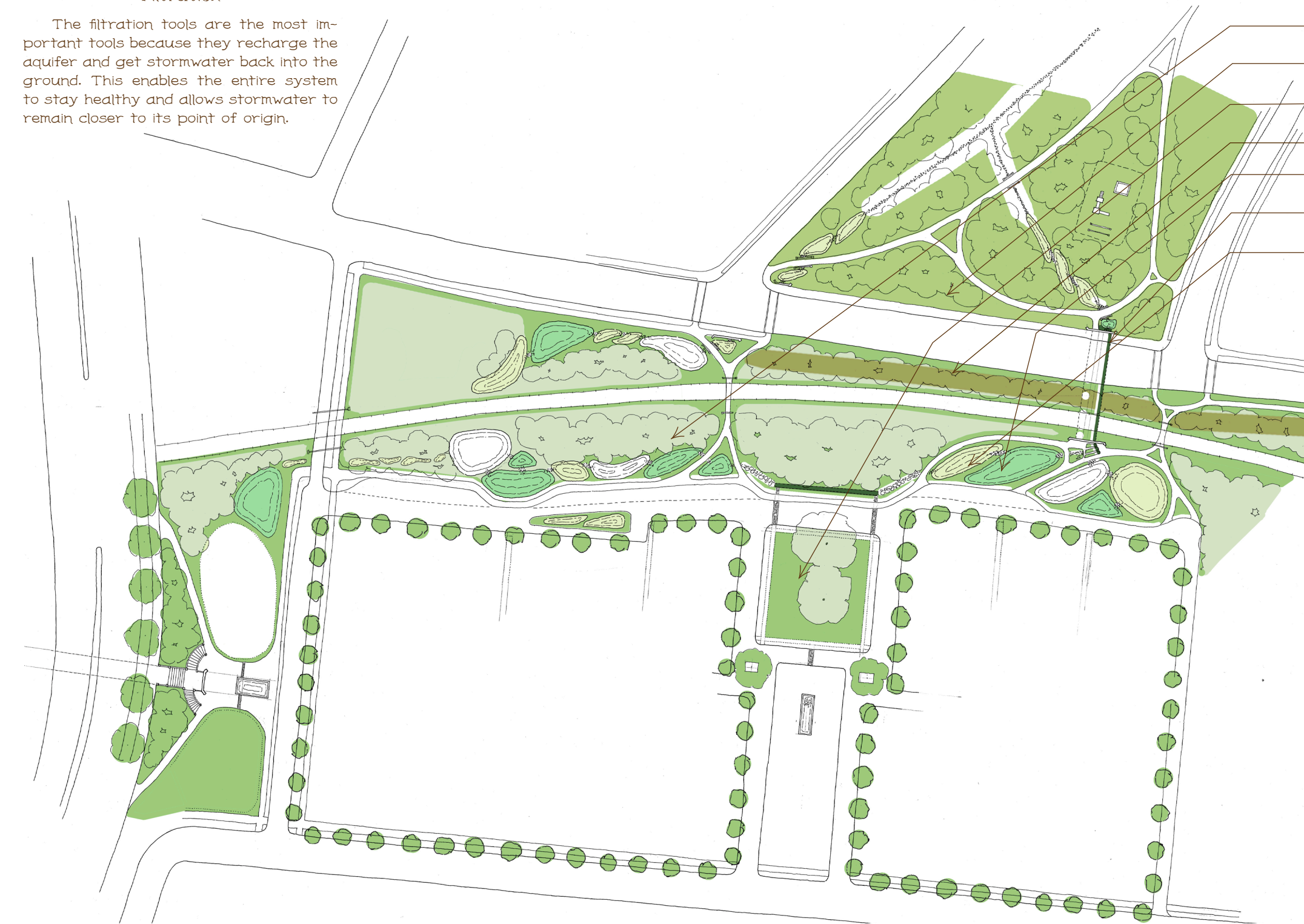
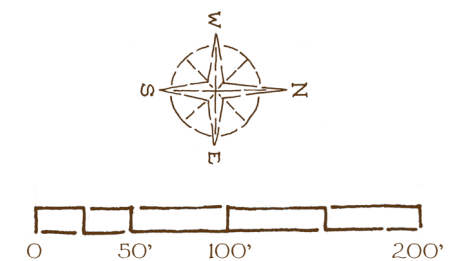
GREENSBORO, NORTH CAROLINA

Light Imprint ~

Filtration

The filtration tools are the most important tools because they recharge the aquifer and get stormwater back into the ground. This enables the entire system to stay healthy and allows stormwater to remain closer to its point of origin.

- Natural Vegetation
- Green Finger
- Surface Landscape
- Bioretention Swale
- Rain Garden
- Waterscape
- Vegetative Purification Bed



Light Imprint ~

Sculpted Waterscape Detail

The detail to the right shows the sculpted watercourse underneath the railroad right of way and Church Street. This waterscape and tunnel would connect Fisher Park and the greenway, allowing people to freely travel between the two. This light imprint tool is also shown on the light imprint overlay on previous pages in plan.





LIGHT IMPRINT HANDBOOK

Integrating sustainability and
community design

What is Light Imprint (LI)?

Light Imprint is a green approach to neighborhood design. It employs New Urbanist principles to create compact, walkable, mixed-use neighborhoods. To this, it adds a tool box of techniques to manage stormwater and natural drainage—an ever present environmental challenge that plays a major role in shaping cities and towns.

The Tools

This little book lays out an array of Light Imprint tools, each shown in the context of an actual New Urbanist project. You will find more than sixty techniques for paving streets and walkways, channeling and storing water, and filtering surface runoff before release into the underground water table. The tools are useful in both new development and existing communities. Done thoughtfully, this seemingly mundane engineering work not only improves the environment, but also can make neighborhoods more beautiful and livable.

The Transect

Beware, not every tool will work in every situation. That is why we have organized them according to an idea borrowed from New Urbanism: the transect. What is the transect? Well, imagine a slice of land, extending from the most rural countryside to the heart of a skyscraper city. Here, on the opposite page, is a sketch. Look at it, and it is easy to begin to visualize how different approaches work best in particular areas. Hard-surface streets and sidewalks are essential in the heavily trafficked urban core, for instance, but a gravel lane might suffice in a rural district. By fitting the right tool to the right situation, it is possible to save money, improve environmental efficiency, and build in beauty.

Who is this book for?

Anyone who cares about neighborhoods including: Planners, Developers, Architects, Engineers, Public Officials, Investors, and Community Activists.

HOW TO USE LIGHT IMPRINT

You can use Light Imprint

» to develop a strategy for sustainability and pedestrian oriented design in an economical way

» to change the mindset of your community from a suburban model towards a New Urban and traditional neighborhood model.

» to reduce costs associated with conventional engineering practices

» to provide an organizational framework to complement and expand the effectiveness of Leadership in Energy Efficient Design for Neighborhood Development (LEED-ND)

» to complement other land planning approaches, including conventional suburban development, Low Impact Development, and Best Management Practices.

The next few pages discuss the content and format of Light Imprint.

FORMAT

Light Imprint is presented in two formats: the Handbook and the Website. These are meant to complement each other. All of the content of the handbook is available on the website in a searchable, user-friendly way. The website also includes additional photos and resources; it will be updated in real time. As Light Imprint evolves, more tools and relevant case studies will be added.

The Handbook

The majority of the handbook is devoted to the organization of Light Imprint tools. The Light Imprint Matrix is the primary organizing method.

The matrix is a summary of the Light Imprint tools described in the Light Imprint Handbook. It is a quick reference to which tools can be utilized to best implement LI techniques; it also shows where tools are most appropriately located along the transect.

General Tool Selection

LI tools are selected to be as inclusive as possible, offering a wide spectrum of solutions. LI emphasizes well-tested tools, techniques, and methods that some consider intrinsically green. Tools that are excluded usually involve highly technological and complex devices dependent on

machines and systems whose cost and benefits are questionable.

Organization

To create a simple framework, the LI tools are classified into four main categories: Paving, Channeling, Storage and Filtration. Clearly, some tools can be used for more than one function. The LI Team's approach is to classify most tools by their principal function and refer to their benefits in other categories. For example, some tools in Storage may also be useful for Filtration.

The Transect

The Transect Zone Matrix is designed to serve as an organizational framework and is by its nature somewhat subjective. The LI Team suggests where on the rural to urban scale each tool is most useful. Depending on location

LIGHT IMPRINT CLASSIFICATIONS:

Transect

- T1 - Natural
- T2 - Rural
- T3 - Sub-urban
- T4 - General Urban
- T5 - Urban Center
- T6 - Urban Core

Initial Cost

- Low
- Medium
- High

Maintenance Cost

- Low
- Medium
- High

Slope

- Flat
- Moderate
- Steep

Climate

- Cold
- Temperate
- Hot
- Dry
- Moderately Wet
- Wet

Soil Quality

- Poor Drainage
- Medium Drainage
- Good Drainage

on the transect, each project will have a specific set of needs.

Cost

Providing specific costs for products, material, labor, and maintenance for a particular project is not the main intent of this handbook. Initial costs and maintenance costs vary widely depending on location and availability of materials and labor. The given costs, therefore, are well-researched approximations. Resources are provided for tools to enable detailed cost estimates for specific projects.

Many of the tools involve the use of plant material and natural vegetation. This book is not intended to be a plant selection guide. Although the LI Team is supportive of using native species, the members do

understand that some non-native plants, where appropriate, can be adapted to local conditions. Non-native, invasive species should only be considered if maintained by knowledgeable caretakers. Engaging a horticulturalist with expertise in native plants is recommended.

Slope

Slope is determined by percentages of change in elevation over a certain distance. Typically, slope is analyzed to determine appropriate locations for drainage, roads, buildings, and other infrastructure. Special consideration must be given when slopes exceed reasonable grades for thoroughfares and infrastructure layouts.

LI design is said to lie lightly on the land. It promotes respect for the existing topography. The

INTRODUCTION

How to Use Light Imprint

tools have been selected to avoid significant grading and landscape disturbance wherever possible. It takes into consideration natural features, including ridges, valleys, drainage corridors, natural ecologies, and habitats. LI uses a three-part classification of slope as follows:

- » Flat - 0-8%
- » Moderate - 8-15%
- » Steep - greater than 15%

Climate

Climate, the generally prevailing regional weather conditions (including precipitation and temperature) averaged over a series of years, is classified in a variety of ways throughout the United States and the world. LI uses the following six variables to define different climatic conditions:

- »Cold - Average low below 32°F (0°C) for more than three months per year
- »Temperate - Average low of below 32°F (0°C) for one to three months per year
- »Hot - Average low never drops below 32°F (0°C)
- »Dry - Average precipitation less than 10 inches (254 mm) per year
- »Moderately Wet - Average precipitation between 11 and 60 inches (255-1,524 mm) per year
- »Wet - Average precipitation more than 60 inches (1,524 mm) per year

Soils

Soil classification, often referred to as hydrology, is a very complex and much debated

process. It is based on soil characteristics, which include additions, transformation, translocation, and removal. When combined, the characteristics describe the soil development process and composition. Due to the many variables, there are at least fifteen widely recognized soil classifications.

Soils have also been generalized into five broader types based on particulate size. Particulate size type and soil composition are represented by the soil texture triangle. This is useful in determining the drainage capabilities of soil with a given composition. This does not take into consideration the nutrient makeup of the soil. LI uses a three-part soils classification as follows:

- » Poor Drainage - rock & clay
- » Medium Drainage - silt & loam
- » Good Drainage - loam & sand

Accessibility

Accessibility is an important factor in selecting tools, especially in the Paving category. These issues must be considered when calibrating each specific project. Life safety and fire codes shall always take precedence over the use of any tools.

Case Studies

Five communities are profiled as examples using Light Imprint. They provide a broad range of LI applications over a range of conditions based on topography, climate, soil, drainage, and development status. Projects chosen for case studies include the following:

Monteagle ~ Located on the Cumberland Plateau of the Tennessee mountains, the historic precedent of Monteagle uses LI tried and tested tools.

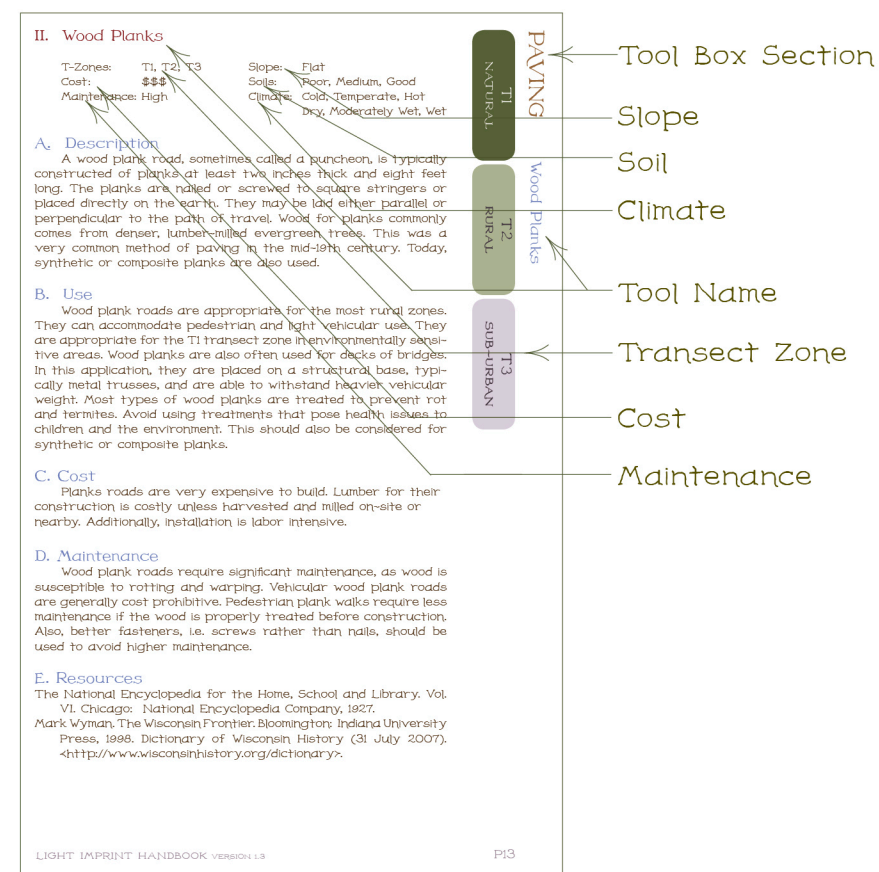
Habersham - Located on the coastal plain of South Carolina, Habersham's flat topography is enhanced by wetlands and sandy soil. Construction is nearly complete.

Griffin Park - Located in the rolling South Carolina foothills, Griffin Park is crisscrossed with creeks and rivers, and has clay

soils. The development is new and under construction.

Lockett - Located in Tennessee on the shoreline of the Cumberland River, Lockett has steep mountain slopes, bluffs, and ravines; it has rocky soil. It is a newly-planned New Urbanist community, conserving significant open space, designed with LI in mind.

Cheshire - Located in North Carolina at the foot of the Black Mountains, Cheshire is crossed by a creek and has clay soils. The general neighborhood of



Sample Toolbox Page

INTRODUCTION

How to Use Light Imprint

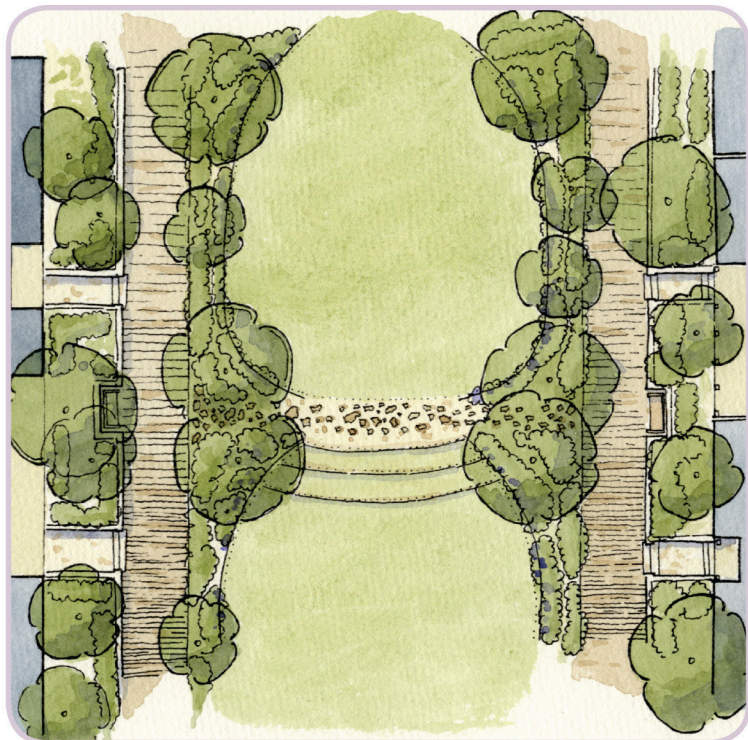
PAVING

Stabilization Mat

T2
RURAL

T3
SUB-URBAN

T4
GENERAL
URBAN



T3 - Stabilization Mat - Carlton Landing, OK - Detail w/Wood Plank and Bio-Retention Swale all combined as a Green Street

III. Stabilization Mat

T-Zones:	T2, T3, T4	Slope:	Steep, Moderate, Flat
Cost:	\$	Soils:	Poor, Medium, Good
Maintenance:	Low	Climate:	Cold, Temperate, Hot Dry, Moderately Wet, Wet

A. Description

A stabilization mat is a tightly woven grid of plastic cells manufactured in large rolls. It is generally a very thin material. Following installation, it is covered with soil and sown with grass seed.

B. Use

Stabilization mats are primarily used for soil stabilization under the hard surface of paved roads or on steep slopes. It may be used in T2, T3, and T4 transect zones for steep pedestrian paths that are subject to erosion. It can provide reinforcement of swale slopes. Since it is not a heavy load bearing system it is unsuitable for vehicular use, unless used in combination with another paving material.

C. Cost

Stabilization mats are mass-produced for multiple applications. Installation is simple and requires little soil preparation. As a result, this is a very inexpensive material to use for light duty paving.

D. Maintenance

Once properly installed, a stabilization mat has little or no associated maintenance unless it is dislodged or damaged by heavy vehicular weight or erosion. It becomes integrated in the root system of the vegetation planted in the grid of cells.

E. Resources

<Technostroytex> LLC. "Geosynthetic Materials." Grodno, Belarus: 2008.
<<http://geo-textiles.ru/en/state/AC:-1.1283516549/AA:navID.87/>>.

PAVING

Stabilization Mat

T2
RURAL

T3
SUB-URBAN

T4
GENERAL
URBAN

PAVING

Crushed Stone/Gravel/Shell

T2
RURAL

T3
SUB-URBAN

T4
GENERAL
URBAN



T2 ~ Gravel ~ Big Canoe, GA

IV. Crushed Stone/Gravel/Shell

T-Zones:	T2, T3, T4	Slope:	Moderate, Flat
Cost:	\$	Soils:	Poor, Medium, Good
Maintenance:	Medium	Climate:	Cold, Temperate, Hot Dry, Moderately Wet, Wet

A. Description

Crushed stone, gravel, and shell (or any non-bound aggregate material) spread over soil can be used for paving. This method uses abundant natural materials, such as stone and shells, as well as recycled materials like crushed brick and concrete. The strength of the material is based on the hardness of the aggregate and the stability of the soil. Mineral aggregates, such as limestone, dolomite, granite, and quartz, are generally the strongest type of aggregate. Compacting the soil before applying the crushed stone, gravel or shell material also increases the strength of the material.

B. Use

Crushed stone, gravel, and shell can withstand moderate, low-speed vehicular use as well as pedestrian use. That makes it especially appropriate for the T2 and T3 transect zones. This material is often used for parking areas, alleys, and rear lanes. It is a good choice for pedestrian paths within parks. This paving method is structurally flexible. It can be placed over non-compacted soil, or it can be used in regions susceptible to soil displacement caused by freeze/thaw cycles. The stability of crushed stone, gravel, and shell is increased when a stabilization mat is used between the aggregate and soil base.

C. Cost

The cost of this paving method varies by the type and quantity of aggregate used. Generally, it is inexpensive, especially when locally abundant materials are used.

D. Maintenance

Most of the maintenance required is due to erosion and the development of potholes and ruts. Heavy vehicular use may result in displacement of the material. In that case, more aggregate can be spread. In dry areas, proper care should be taken to avoid airborne dust caused by vehicular use.

E. Resources

Bruce K. Ferguson, Porous Pavements. Boca Raton, FL: CRC Press, 2005.

PAVING

Crushed Stone/Gravel/Shell

T2
RURAL

T3
SUB-URBAN

T4
GENERAL
URBAN

PAVING

Crushed Stone/Gravel/Shell

T2
RURAL

T3
SUB-URBAN

T4
GENERAL
URBAN



T3 ~ Crushed Shell ~ Edenton, NC



T4 ~ Crushed Stone Parking ~ Chestnut Hill, PA

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LIGHT IMPRINT HANDBOOK VERSION 1.3

PAVING

Crushed Stone/Gravel/Shell

T2
RURAL

T3
SUB-URBAN

T4
GENERAL
URBAN



T2 ~ Gravel ~ Oklahoma City, OK



T3 ~ Gravel ~ Isle of Hope, GA

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LIGHT IMPRINT HANDBOOK VERSION 1.3

PAVING

Crushed Stone/Gravel/Shell

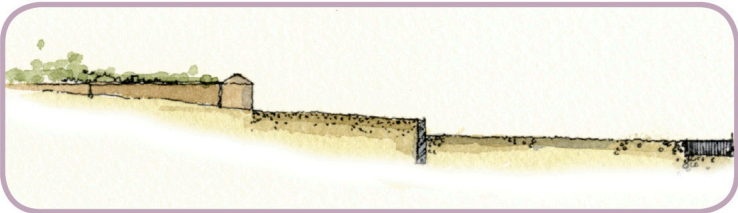
T2
RURAL

T3
SUB-URBAN

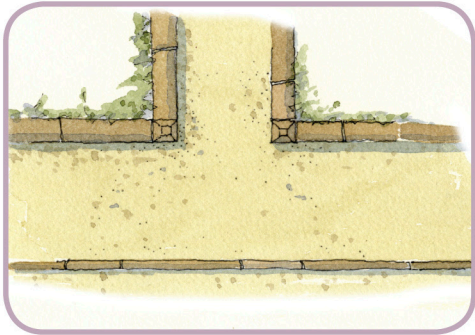
T4
GENERAL
URBAN



T4 - Crushed Stone Sidewalk ~ Monteagle, TN



T4 - Crushed Stone ~ Typical Sidewalk Entry



T4 - Crushed Stone ~ Typical Sidewalk Entry

PAVING

Crushed Stone/Gravel/Shell

T2
RURAL

T3
SUB-URBAN

T4
GENERAL
URBAN



T3 ~ Crushed Stone ~ Cheshire, NC

PAVING

Pervious Asphalt

T3
SUB-URBAN

T4
GENERAL
URBAN

T5
URBAN
CENTER

Continued

E. Resources

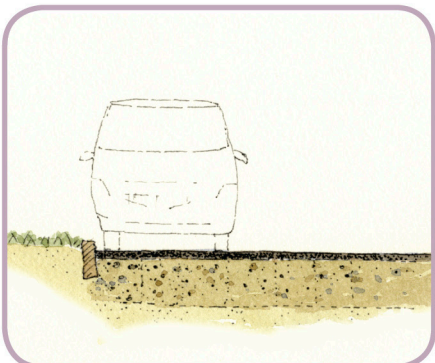
Cahill Associates Environmental Consultants. "Structural Stormwater Technologies". West Chester, Pennsylvania: CA 2003. <www.thcahill.com/pasphalt.html>.

Bruce K. Ferguson, *Porous Pavements*. Boca Raton, FL: CRC Press, 2005.

U.S. Department of Transportation, Federal Highway Administration, "Turner-Fairbank Highway Research Center - Pavement Research." McLean, Virginia: TFHRC (February 5, 2008). <<http://www.fhrc.gov/pavement/pave.htm>>.



T4 ~ Pervious Asphalt



T4 ~ Pervious Asphalt ~ Flowood, AL



T5 ~ Pervious Asphalt ~ Rosemary Beach, FL

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LIGHT IMPRINT HANDBOOK VERSION 1.3

VIII. Pervious Asphalt

T-Zones:	T3, T4, T5	Slope:	Steep, Moderate, Flat
Cost:	\$\$	Soils:	Medium, Good
Maintenance:	Low	Climate:	Temperate, Hot Dry, Moderately Wet, Wet

A. Description

Asphalt is a commonly used term that refers to a material composed of aggregate bound with a black solid or semisolid substance distilled from a petroleum byproduct. Pervious asphalt uses open graded (uniformly sized) aggregate, as opposed to the finely graded (various size) aggregate used in standard asphalt. Using open graded aggregate leaves voids between the aggregate that allow water to flow through. Also, pervious asphalt uses less asphalt binder to ensure that many of the voids between pieces of aggregate are not clogged. Pervious asphalt is laid over an aggregate base that retains stormwater until it can filter through to be absorbed by the subsurface.

B. Use

Like conventional asphalt, pervious asphalt can be used in a diverse array of applications. It is appropriate for use in T3 through T5 transect zones. Due to cost, the use of pervious asphalt in more rural T3 zones may be limited to primary streets and rear lanes that receive moderate vehicular use. In the T4 and T5 zones, pervious asphalt may be used more frequently for primary streets as well as alleys and parking areas. The material is not ideal in heavy vehicular use areas due to its susceptibility to fracture.

C. Cost

The cost of pervious asphalt is slightly higher than conventional asphalt. The installation cost involves the site work needed such as grading, compaction, and sub-base layering. Installation of pervious asphalt for vehicular use will have a much higher cost than the installation of a pedestrian foot path.

D. Maintenance

The lifecycle cost of pervious asphalt is inexpensive, and similar to conventional asphalt. It requires periodic maintenance, such as biannual vacuuming, but this may be done in sections. In areas of heavy vehicular use, it is important to obtain the proper bitumen mix to prevent imperviousness due to compression.

Continued

LIGHT IMPRINT HANDBOOK VERSION 1.3

PAVING

Pervious Asphalt

T3
SUB-URBAN

T4
GENERAL
URBAN

T5
URBAN
CENTER

P33

PAVING

Asphalt

T3
SUB-URBAN

T4
GENERAL
URBAN

T5
URBAN
CENTER

T6
URBAN
CORE

P36



T3 ~ Asphalt ~ Habersham, SC



T4 ~ Asphalt ~ Prospect, CO

LIGHT IMPRINT HANDBOOK VERSION 1.3

IX. Asphalt

T-Zones:	T3, T4, T5, T6	Slope:	Steep, Moderate, Flat
Cost:	\$	Soils:	Poor, Medium, Good
Maintenance:	Low	Climate:	Cold, Temperate, Hot Dry, Moderately Wet, Wet

A. Description

Asphalt is a common paving material composed of finely graded aggregate bound with a black solid or semisolid substance distilled from a petroleum byproduct. Approximately ninety-four percent of all streets in the United States are paved with asphalt. The method is derived from the Macadam process. That process, which used tar to bind the aggregate, was the first innovation in paving to replace compacted dirt roads. Now, the binding material is bitumen, a byproduct of crude oil distillation, which is less harmful to the environment.

B. Use

Asphalt is a semi-flexible paving material that never completely hardens. It is spread over a compacted sub-base; it is a highly adaptable material. Asphalt can be used in a diverse array of applications. It is appropriate for use in all transect zones except T1 and T2. In more sub-urban zones such as T3, the use of asphalt may be limited to primary streets and rear lanes that receive moderate vehicular use. In the T4 through T6 zones, asphalt may be used more often for primary streets, alleys, and parking areas. It can withstand heavy truck use. It is subject to ruts, cracks, and potholes with heavy vehicular use over time.

C. Cost

Asphalt is an inexpensive paving material. The materials are readily available; the installation process is widely known and relatively fast. The installation cost involves the site work needed, such as grading, compaction, and sub-base layering. The initial cost, including materials, may range from \$2 to \$8 per square foot (\$20 to \$80 per square meter).

D. Maintenance

Over its lifecycle, the cost of asphalt is inexpensive. Due to the relative softness of the material, periodic maintenance for ruts, potholes, and cracks is necessary. That may be done in sections as needed.

E. Resources

California Department of Transportation. "Roadside Management Toolbox." Sacramento, California: Caltrans, 2007. <<http://www.dot.ca.gov/hq/LandArch/roadside/index.htm>>
Bruce K. Ferguson, Porous Pavements. Boca Raton, FL: CRC Press, 2005.
National Asphalt Pavement Association. "All About Asphalt" (21 August 2007). <<http://www.hotmix.org>>

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PAVING

Asphalt

T3
SUB-URBAN

T4
GENERAL
URBAN

T5
URBAN
CENTER

T6
URBAN
CORE

P35

PAVING

Concrete

T3
SUB-URBAN

T4
GENERAL
URBAN

T5
URBAN
CENTER

T6
URBAN
CORE



T3 ~ Concrete ~ Jekyll Island, GA



T4 ~ Concrete ~ Hendrix College, AR

P40

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T4 ~ Concrete ~ Sicily, Italy



T5 ~ Concrete ~ Eureka Springs, AR

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PAVING

Concrete

T3
SUB-URBAN

T4
GENERAL
URBAN

T5
URBAN
CENTER

T6
URBAN
CORE

P41

PAVING

Stamped Concrete

T3
SUB-URBAN

T4
GENERAL
URBAN

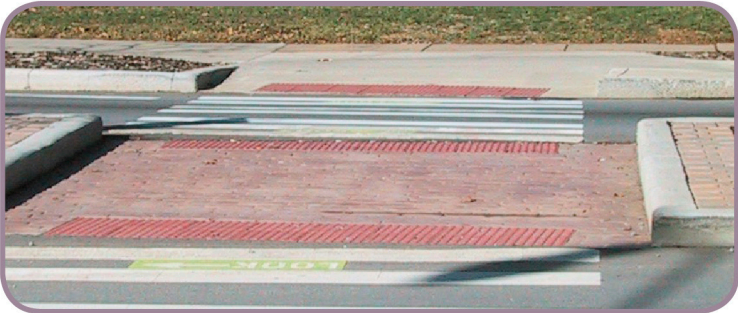
T5
URBAN
CENTER

T6
URBAN
CORE

P48



T4 ~ Stamped Concrete ~ Naples, FL



T5 ~ Stamped Concrete ~ Asheville, NC

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XIII. Stamped Concrete

T-Zones:	T3, T4, T5, T6	Slope:	Steep, Moderate, Flat
Cost:	\$\$\$	Soils:	Poor, Medium, Good
Maintenance:	High	Climate:	Cold, Temperate, Hot Dry, Moderately Wet, Wet

A. Description

Concrete is a material used for many construction applications. It consists of cement (most often Portland Cement), aggregate (usually gravel and sand), water and admixtures. In road construction, it is poured onsite. Stamped concrete, similar in method to stamped asphalt, is imprinted with a pattern or decorative design while the concrete is still wet. The stamp allows the concrete to resemble different materials such as brick, stone, tile, slate, or wood. Concrete may also be dyed a color that closer emulates the chosen material. The light color of concrete allows for flexibility in design and color options.

B. Use

This material retains the properties of standard concrete. It is rigid, strong, durable; and watertight; it strengthens over time. Its strength also makes it appropriate for areas with steep slopes. It is suitable for heavy vehicular volume and weight. Stamped concrete is available in both pervious concrete and standard concrete.

C. Cost

Stamped concrete is quick to apply. It costs significantly less than the material the pattern is emulating, such as stone or brick; it is estimated to cost about 33% less. Costs are around \$6 to 9\$ per square foot (\$65 to \$95 per square meter).

D. Maintenance

Stamped concrete requires consistent maintenance to retain an authentic look. The amount of cracking usually varies with the pattern installed. The color is apt to fade with use; it requires resealing every two to three years. Color matching during repairs is also difficult.

E. Resources

California Department of Transportation. "Roadside Management Toolbox." Sacramento, California: Caltrans, 2007. <<http://www.dot.ca.gov/hq/LandArch/roadside/index.htm>>
Concrete Network.com. "Stamped Concrete," 2008. <http://www.concretenetwork.com/concrete/stamped_concrete/>

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PAVING

Stamped Concrete

T3
SUB-URBAN

T4
GENERAL
URBAN

T5
URBAN
CENTER

T6
URBAN
CORE

P47

PAVING

Stone/Masonry Paving Blocks



T4 ~ Masonry Paving Blocks ~ Campo Sano, FL

T4
GENERAL
URBAN

T5
URBAN
CENTER

T6
URBAN
CORE

P54



T4 ~ Stone Paving Blocks ~ Alys Beach, FL

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XV. Stone/Masonry Paving Blocks

T-Zones:	T4, T5, T6	Slope:	Steep, Moderate, Flat
Cost:	\$\$\$	Soils:	Poor, Medium, Good
Maintenance:	Low	Climate:	Cold, Temperate, Hot Dry, Moderately Wet, Wet

A. Description

Stone pavers are solid blocks set on a surface with joints that leave open spaces between each unit. The joints may be filled with mortar, sand, soil, or pervious material such as pea gravel or other loose aggregate. Other options are to plant grass in the joints or leave them empty. This common paving material has been used throughout history; it is still widely used today.

Since stone is a naturally occurring, abundant material that varies by region, many varieties of stone paving blocks are available. Some common types of stone include limestone, fieldstone, granite, marble, quartz, and slate. The diversity of stone provides great flexibility in design.

B. Use

Stone pavers form a semi-rigid grid system. They can withstand moderate to heavy vehicular use. Due to the flexibility of the system, the pavers can accommodate some subsurface soil displacement caused by freeze/thaw cycles.

When the joints are filled, stone pavers provide a rigid surface and can accommodate the heaviest weights. When the joints are not filled with aggregate or some pervious material, stone pavers should not be placed on extreme slopes or in areas where sediment is prevalent.

C. Cost

Stone paver blocks are usually expensive when first installed. The initial cost depends on the size of the pavers and the type of material used to fill the joints. Since each block must be laid individually, the cost of labor adds to the total cost of this paving method.

D. Maintenance

Stone paver blocks require little maintenance. That keeps costs low over the lifecycle of the material. The material is available in individual units allowing easy replacement should one unit be damaged. If placed in an area of heavy vehicular traffic, the filler used in the joints may need to be replenished on a regular basis. Joints filled with grass may need additional seeding.

E. Resources

Bruce K. Ferguson, [Porous Pavements](#). Boca Raton, FL: CRC Press, 2005.

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PAVING

Stone/Masonry Paving Blocks

T4
GENERAL
URBAN

T5
URBAN
CENTER

T6
URBAN
CORE

P53

PAVING

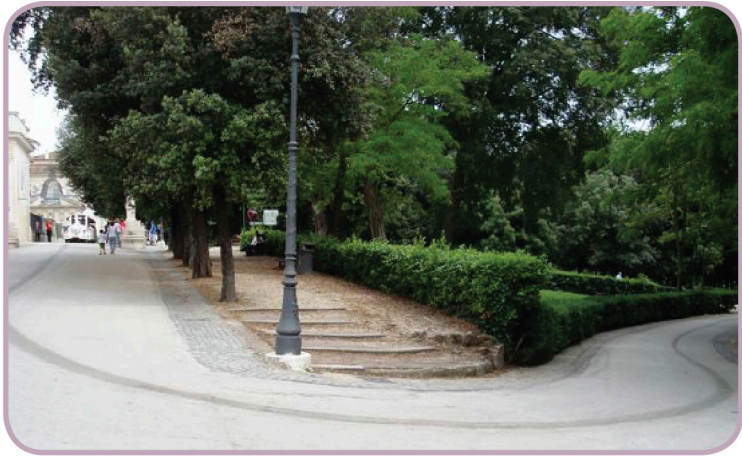
Stone/Masonry Paving Blocks

T4
GENERAL
URBAN

T5
URBAN
CENTER

T6
URBAN
CORE

P56



T4 ~ Stone Paving Blocks ~ Rome, Italy



T4 ~ Stone Paving Blocks ~
Rome, Italy



T4 ~ Stone Paving Blocks ~
Barcelona, Spain

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T4 ~ Stone Paving Blocks ~ London, England



T5 ~ Stone Paving Blocks ~ Philadelphia, PA

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PAVING

Stone/Masonry Paving Blocks

T4
GENERAL
URBAN

T5
URBAN
CENTER

T6
URBAN
CORE

P55

PAVING

Stone/Masonry Paving Blocks

T4
GENERAL
URBAN

T5
URBAN
CENTER

T6
URBAN
CORE

P58



T6 ~ Stone Paving Blocks ~ New Orleans, LA



T6 ~ Stone Paving Blocks ~ Installation

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PAVING

Stone/Masonry Paving Blocks

T4
GENERAL
URBAN

T5
URBAN
CENTER

T6
URBAN
CORE

P57



T4 ~ Masonry Paving Blocks ~ Rome, Italy



T5 ~ Stone Paving Blocks ~ Rome, Italy

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T6 ~ Stone Paving Blocks ~ Rome, Italy



T5 ~ Masonry Paving Blocks ~ Winter Park, FL

PAVING

Stone/Masonry Paving Blocks

T4
GENERAL
URBAN

T5
URBAN
CENTER

T6
URBAN
CORE

PAVING

Wood Paving Blocks on Concrete

T4
GENERAL
URBAN

T5
URBAN
CENTER

T6
URBAN
CORE

P62



T5 ~ Wood Block Street ~ Philadelphia, PA

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XVI. Wood Paving Blocks on Concrete

T-Zones:	T4, T5, T6	Slope:	Moderate, Flat
Cost:	\$\$\$	Soils:	Medium, Good
Maintenance:	Low	Climate:	Cold, Temperate, Hot Dry, Moderately Wet, Wet

A. Description

Wood paving blocks have been used for road construction since the 14th century. Originally, they were made of many different species of wood placed directly on the soil. The uneven surfaces were prone to rot. Eventually, the blocks were covered with creosote, a thick oily substance derived from coal tar. Gravel was placed in the joints. Then the entire system was covered with tar to provide a stronger, more uniform traffic surface. Presently, wood paving blocks are placed on a stabilized base; their joints are filled with either gravel or concrete. Treatment of the blocks prevents swelling caused by water absorption.

B. Use

Wood paving blocks can withstand the light vehicular use found in some urban areas. They are often used to evoke an historic character. Since wood is a flexible crack-resistant material, wood paving blocks are also ideal for streets prone to vibration near railroad tracks or parking garages. The sound absorption characteristic of wood helps quiet traffic noise on urban residential streets.

C. Cost

Both the preparation and installation of wood paving blocks are expensive. Pine is the species of wood commonly used for the blocks. The cost of materials varies by locale.

D. Maintenance

Wood paving blocks, when laid with the grain perpendicular to the soil surface, are very strong. When used in appropriate settings, they require little maintenance. That keeps costs low over the life cycle of the material. The material is available in individual units allowing easy replacement should one unit be damaged.

E. Resources

- David H. Jurney. "Wood Street Paving: A Forgotten Technology." *Legacies: A History Journal for Dallas and North Central Texas*, 7.1, 1995. <<http://www.smu.edu/anthro/collections/woodstreets.html>>
- Bob Kindred. "Wood Block Paving." *Context* 41 (March 1994).
- David O. Whitten. "A Century of Parquet Pavements: Wood as a paving material in the United States and abroad, 1840-1940." *Essays in Economic and Business History* 25, 1997: 209-26.

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PAVING

Wood Paving Blocks on Concrete

T4
GENERAL
URBAN

T5
URBAN
CENTER

T6
URBAN
CORE

P61



T5 ~ Wood Block Street ~ Jekyll Island, GA



T4 ~ Wood Block Street ~ Charleston, SC

PAVING

Wood Paving Blocks on Concrete

T4
GENERAL
URBAN

T5
URBAN
CENTER

T6
URBAN
CORE

CHANNELING

Vegetative Swale

T1
NATURAL

T2
RURAL

T3
SUB-URBAN



T2 ~ Vegetative Swale ~ Vancouver, BC



T3 ~ Vegetative Swale ~ Orlando, FL

C14

LIGHT IMPRINT HANDBOOK VERSION 1.3

III. Vegetative Swale

T-Zones:	T1, T2, T3	Slope:	Steep, Moderate, Flat
Cost:	\$	Soils:	Medium, Good
Maintenance:	Low	Climate:	Cold, Temperate, Hot Dry, Moderately Wet, Wet

A. Description

Vegetative swales are usually manmade depressions (though some occur naturally), that filter and collect runoff. The swales are open and fairly shallow to treat small quantities of sheet runoff. Vegetated swales differ from drainage ditches in that they are planted with vegetation, which serves as an overland filtration tool and controls erosion. This tool should be used to collect and treat sheet flow runoff before reaching a stream. The vegetation planted in these swales should be native plants that are suitable to variable moisture ranges. Existing topsoil is preferred if conditions allow.

B. Use

Vegetative swales, because of their ground plane space requirements and more natural aesthetics, are used in edge conditions of development. T1 and T2 are suitable zones for these swales with natural vegetation, but they can also be incorporated into T3 zones if vegetation is carefully selected. The slopes of the swales should not exceed 3:1 to avoid the requirement for a protective barrier. Vegetative swales are not used in more urban conditions because they disrupt the connectivity of streets and impede pedestrian movement. They also have more difficulty retaining the amount of runoff that comes from the increase in impervious surfaces.

C. Cost

The cost of vegetative swales is very low. The only cost is the initial purchase of the needed vegetation to be planted.

D. Maintenance

Since the vegetative swales are planted, they do not require mowing like drainage ditches. Periodic weeding will be needed to assure healthy planted vegetation growth. Some vegetation may need watering in the case of a severe drought.

E. Resources

Metro: People Places Open Spaces. "GreenStreets: Innovative Solutions for Stormwater and Stream Crossings" Portland: Metro, 2002.

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CHANNELING

Vegetative Swale

T1
NATURAL

T2
RURAL

T3
SUB-URBAN

C13

CHANNELING

Vegetative/Stone Swale

T2
RURAL

T3
SUB-URBAN

T4
GENERAL
URBAN



T2 - Vegetative/Stone Swale - Habersham, SC



T2 - Vegetative/Stone Swale - Habersham, SC

C20

LIGHT IMPRINT HANDBOOK VERSION 1.3

VI. Vegetative/Stone Swale

T-Zones:	T2, T3, T4	Slope:	Moderate, Flat
Cost:	\$	Soils:	Medium, Good
Maintenance:	Low	Climate:	Temperate, Hot Dry, Moderately Wet, Wet

A. Description

A vegetative and stone swale is another type of swale. It is distinguished from the others because it uses small stones as a base to help absorb the water faster. These swales are slight depressions planted with manicured grass and have a three to five inch base of small stones. In some cases, the periodic placement of wooden weirs can help impede flow in the event of a heavier rainstorm. The vegetative and stone swales transport stormwater to retention areas, with the goal of allowing stormwater to infiltrate into the ground as it is channeled. This type of swale is most effective in more porous soils.

B. Use

This type of swale is best utilized in medium density zones of the transect because of its more natural function combined with a manicured look. It can be an attractive feature in a park or next to a sidewalk. This type of swale can easily be crossed with a wooden pedestrian bridge.

C. Cost

The only additional cost compared to a vegetative swale is the stone base. Other than the stones, there is little initial cost and maintenance cost.

D. Maintenance

Swales are easy to maintain because they are open. The most important maintenance is keeping swales clear of debris and trimming back the ground cover around them. The stones rarely need replacing. To ensure the stones stay in place, a gabion can be used for erosion control. A gabion is typically either a wire cage placed over stones to prevent erosion or a soft material, such as jute or synthetic matting, that performs the same function.

E. Resources

Metro: People Places Open Spaces. "GreenStreets: Innovative Solutions for Stormwater and Stream Crossings" Portland: Metro, 2002. 57-59.

LIGHT IMPRINT HANDBOOK VERSION 1.3

CHANNELING

Vegetative/Stone Swale

T2
RURAL

T3
SUB-URBAN

T4
GENERAL
URBAN

C19

CHANNELING

Vegetative/Stone Swale

T2
RURAL

T3
SUB-URBAN

T4
GENERAL
URBAN



T3 ~ Vegetative/Stone Swale ~ Houston, TX

C22

LIGHT IMPRINT HANDBOOK VERSION 1.3



T2 ~ Vegetative/Stone Swale ~ Habersham, SC



T2 ~ Vegetative/Stone Swale ~ Habersham, SC

LIGHT IMPRINT HANDBOOK VERSION 1.3

CHANNELING

Vegetative/Stone Swale

T2
RURAL

T3
SUB-URBAN

T4
GENERAL
URBAN

C21

CHANNELING

Shallow Channel Footpath / Rainwater Conveyor

- T3
SUB-URBAN
- T4
GENERAL
URBAN
- T5
URBAN
CENTER



T3 ~ Shallow Channel Footpath ~
Oklahoma City, Oklahoma



T3 ~ Rainwater Conveyor ~
Serenbe, GA

XIII. Shallow Channel Footpath/
Rainwater Conveyor

T-Zones:	T3, T4, T5	Slope:	Steep, Moderate, Flat
Cost:	\$	Soils:	Medium, Good
Maintenance:	Low	Climate:	Cold, Temperate, Hot Dry, Moderately Wet, Wet

A. Description

A shallow channel footpath is a slight depression in the earth with pavers in the lowest point of the depression. It is a walkable path when dry, but the depression enables it to convey water in the event of rainfall. The pavers are usually a variety of flat stones loosely arranged to keep a pedestrian's feet dry when the ground is wet.

B. Use

The shallow channel footpath is best used in more urban areas because they accommodate pedestrian traffic. They work well for parks and mid-block pedestrian paths. The shallowness prevents the channels from conveying a large amount of runoff. The channels can be used, however, to receive some water from the rest of the stormwater system. Native shrubs along the channel's edge help slow and filter the flow of water into the channel. In more urban areas, the water may be channeled into underground vaults.

C. Cost

The shallow channel footpath is a low cost channeling tool. The greatest expense is the paver stones. This cost is dependent on the type of stone chosen. Local stones are suggested, and they could be free if available on site.

D. Maintenance

This tool requires very little maintenance. Debris should be cleared regularly and the pavers replaced as necessary.

E. Resources

Herbert Dreiseitl and Dieter Grau. New Waterscapes: Planning, Building and Designing with Water. Boston: Birkhauser, 2001. 88.

CHANNELING

Shallow Channel Footpath/Rainwater Conveyor

- T3
SUB-URBAN
- T4
GENERAL
URBAN
- T5
URBAN
CENTER

CHANNELING

Shallow Channel Footpath / Rainwater Conveyor

- T3
SUB-URBAN
- T4
GENERAL
URBAN
- T5
URBAN
CENTER



T5 ~ Rainwater Conveyor ~ New Orleans, LA

C32

LIGHT IMPRINT HANDBOOK VERSION 1.3



T3 ~ Shallow Channel Footpath ~ Oklahoma City, Oklahoma



T4 ~ Rainwater Conveyor ~ Barcelona, Spain

LIGHT IMPRINT HANDBOOK VERSION 1.3

CHANNELING

Shallow Channel Footpath / Rainwater Conveyor

- T3
SUB-URBAN
- T4
GENERAL
URBAN
- T5
URBAN
CENTER

C31